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**Evaluate the Benefit of New Higher-
Strength HSLA (High Strength, Low
Alloy) Steels**

**U.S. DEPARTMENT OF THE NAVY
CARDEROCK DIVISION,
NAVAL SURFACE WARFARE CENTER**

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EVALUATE THE BENEFIT OF NEW HIGHER-STRENGTH
HSLA (HIGH STRENGTH, LOW ALLOY) STEELS

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EVALUATE THE BENEFIT OF NEW HIGHER-STRENGTH HSLA STEELS

As the continuing search for offshore oil heads toward deeper water, the need for sturdier designs and stronger steels multiplies. Thus the costs to build mobile drilling units and fixed platforms rise exponentially.

Steels with 50, 60, 65, 75, 80, and 100 ksi (thousand pounds per square inch) yield points in both the HSLA normalized and C-Mn-Si (Carbon-Manganese-Silicon) quenched and tempered conditions are available from various producers. Most of these steels above 1-1/2 inches in thickness must be welded to themselves or other steels by using sustained preheat and controlled interpass temperatures, plus controlled welding heat input of approximately 50 to 60 KJ/inch (kilo joules per inch). These two items will add as much as 50 percent to the cost of welding when using the submerged-arc process. Cost increases up to 30 percent can be expected when stick welding under these conditions. The practice of using hand-held oxy-gas torches, by the welder, to drive out moisture or raise the steel above freezing conditions is considered as normal, with its cost usually included in the standard welding costs.

In our design improvement and cost reduction efforts, we found a steel capable of being welded without sustained preheat or limited heat input. This quenched and precipitation hardened steel is ASTM A710 Grade A Class 3. Due to its high degree of weldability, it shows great potential

for sizeable savings in welding costs. The use of HSLA-80, which is an 80,000 yield point material and a derivative of this specification, on Navy ships has been documented by SP-7 panel member L. G. Kvidahl of Ingalls Shipbuilding on page 42 of the July, 1985, issue of the "Welding Journal." This product has also been known in the trade as Armco's "NI-COP."

We proposed, through SP-7, to MARAD that a study, entitled as above, be conducted to fully explore the potential of this product. Work commenced in August, 1984, to accomplish the following goals:

<u>Phase</u>	<u>Goal - Expected and Proven Results</u>	<u>Estimated cost</u>	<u>Scheduled Time</u>
1A	80 ksi Y.P. through 3" thick	\$ 95,000	1 year
1B	75 ksi Y.P. through 5" thick 70 ksi Y.P. through 6" thick	\$ 75,000	9 months
2	100 ksi Y.P. through 3" thick	\$ 70,000	6 months
3	90 ksi Y.P. through 5" thick 85 ksi Y.P. through 6" thick	\$100,000	1 year
4	Publish results and develop market for proven products	\$ 50,000	9 months
TOTALS		\$390,000	4 years

As of mid-September we have finished our first year's effort. During this time we have welded 24 test plates, 20 of which have been tested.

The processes used were manual, gas metal-arc with pulse, and submerged arc (single, dual arc, and narrow gap). Heat inputs varied from 50 KJ/inch to 200 KJ/inch. Some plates were welded in the quenched only condition, and precipitation hardened after welding, others vice versa. Test results obtained thus far show a minimum yield of 84.7 ksi welded at 200 KJ/inch with dual arc to 97.6 ksi welded at 100 KJ/inch with the same process. Charpy "Vee" notch values were well above the American Bureau of Shipping values for EQ56 plates.

Some repair work and testing remains to be done to completely attain our Phase 1A goal. However, our initial findings indicate that heat input limitations on this material may not be necessary and the practice of good welding techniques is mandatory. We will continue to explore heat input limitations in our next phase of effort.

At the present time, this HSLA steel costs approximately 45 to 50 percent more than high strength C-Mn-Si quenched and tempered plates at the 50, 60, and 75 yield point ksi level. Potential cost reductions in welding labor costs of 40 percent to 75 percent are probable. This is due to being able to specify and use thinner sections of steel, requiring less volume of weld metal, that can be welded without preheat at very high heat inputs. These labor savings will far exceed the extra material costs by very wide margins.

An evaluation covering the above factors will be presented at the completion of Phase 1B before performing any work on 100 ksi yield point material. In addition, we will present other benefits to be gained by the use of this material. Some may be intangible and difficult to assess.

These include:

1. The use of lighter material decreases the deadweight of the unit, thereby increasing its payload on reducing the power requirements to propel it.
2. Lighter material increases the length or width of plates ordered from the mill. This in turn reduces the number of butts on seams required in the unit's design. Therefore, welding requirements are further reduced.
3. Thinner higher-strength plates of greater surface area to construct a unit will reduce plate handling times at the site. Incoming freight bills will decrease as less tonnage is delivered to the carrier.
4. Less time and effort will be expended by architects and designers in producing the most economical product.

Definition of Terms

HSLA - high strength, low alloy

ksi - thousand pounds per square inch

C-Mn-Si - Carbon-Manganese-Silicon

KJ - kilo joules

Y.P. - yield point

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